

Title:

Design and validity of automated Impedance Cardiogram analysis algorithms for Post-traumatic stress disorder application and interpretation using artificial intelligence framework

Abstract:

Post-traumatic stress disorder (PTSD) is a chronic psychiatric illness that arises from exposure to a traumatic event. PTSD has been identified as an independent risk factor for developing cardiovascular diseases including heart failure, but the underlying cardiac mechanisms are still unclear. An insight into the mechanisms linking PTSD with heart failure can help in developing effective treatment or prevention strategies to reduce the risk of heart failure. Psychophysiological responsivity in individuals with PTSD during trauma recall may help in understanding the linkage between PTSD and heart disease. The commonly used bio-signals provide limited insight into cardiac mechanisms in PTSD. Through impedance cardiogram (ICG) one can assess cardiac mechanical functions and understand more specific mechanisms of stress that relate to heart failure. However, ICG sensitivity to the artifacts from respiration, speaking, motion, and electrode displacement coupled with intra- and inter-subject morphological variability are significant limitations for reliable ICG-based research and clinical applications. This dissertation aims to build the ICG-based signal processing and artificial intelligence frameworks to understand the underlying cardiac mechanisms linking PTSD with heart failure. Therefore, a three-stage ensemble average (TEA) algorithm was designed that provides a robust framework for the removal of noisy ICG beats and accurate estimation of ICG-based parameters. Then, the TEA algorithm was validated in clinical settings for speech tasks in different age groups for evaluation of its potential clinical applications in psychophysiology. An automated data-driven algorithm for the detection of aortic valve opening was designed to increase the accuracy, speed, and reliability of ICG-based analysis without the need for expert visual scoring. Finally, this research identified important ICG-based metrics suggesting increased sympathetic activation and worsened cardiac contractility, which may be concerning for increased heart failure risk after recurrent trauma re-experiencing in PTSD. In this research, the first dedicated ICG open-source toolbox has been established which will act as a benchmark for other studies, help accelerate the field, and aid reproducibility.